# SAMPLE QUESTION PAPER

## BLUE PRINT

**Time :** 2 Hours **Max. Marks :** 35

| S. No. | | Chapter | Section-A (2 marks) | Section-B (3 marks) | Section-C (5 marks) | Total |
|---|---|---|---|---|---|---|
| 8. | Unit-V | Electromagnetic Waves | – | 1(3)# | – | 6(17) |
| 9. | Unit-VI | Ray Optics and Optical Instruments | – | 1(3)* | 1(5) | |
| 10. | | Wave Optics | – | 2(6) | – | |
| 11. | Unit-VII | Dual Nature of Radiation and Matter | – | 1(3) | – | 4(11) |
| 12. | Unit-VIII | Atoms | 1(2)# | 1(3) | – | |
| 13. | | Nuclei | – | 1(3) | – | |
| 14. | Unit-IX | Semiconductor Electronics : Materials, Devices and Simple Circuits | 2(4) | 1(3) | 1(5) | 2(7) |
| | | **Total Questions** | **3(6)** | **8(24)** | **1(5)** | **12(35)** |

*It is a choice based questions.
#Out of the two or more questions only one question is choice based.

## General Instructions :

(i) *There are 12 questions in all. All questions are compulsory.*

(ii) *This question paper has three sections: Section A, Section B and Section C.*

(iii) *Section A contains three questions of two marks each, Section B contains eight questions of three marks each, Section C contains one case study-based question of five marks.*

(iv) *There is no overall choice. However, an internal choice has been provided in one question of two marks and two questions of three marks. You have to attempt only one of the choices in such questions.*

(v) *You may use log tables if necessary but use of calculator is not allowed.*

## SECTION - A

1. Draw *V-I* characteristics of a *p-n* junction diode. Explain, why the current under reverse bias is almost independent of the applied voltage up to the critical voltage.

2. The contribution to the total current in a semiconductor, due to electrons and holes are 0.75 and 0.25 respectively. The drift velocity of electrons is $\frac{3}{2}$ times that of holes at this temperature. Then find the ratio between electron concentration and hole concentration.

3. Show that the radius of the orbit in hydrogen atom varies as $n^2$, where $n$ is the principal quantum number of the atom.

**OR**

The short wavelength limit for the Lyman series of the hydrogen spectrum is 913.4 Å. Calculate the short wavelength limit for Balmer series of the hydrogen spectrum.

## SECTION - B

4. A particle of mass $m$ moves in circular orbits with potential energy $V(r) = Fr$, where $F$ is a positive constant and $r$ is its distance from the origin. Its energies are calculated using the Bohr model. If the radius of the particle's orbit is denoted by $R$ and its speed and total energy are denoted by $v$ and $E$, respectively, then for the $n^{th}$ orbit find the total energy. (Here $h$ is the Planck's constant.)

5. Three photodiodes $D_1$, $D_2$ and $D_3$ are made of semiconductors having band gaps of 2.5 eV, 2 eV and 3 eV respectively. Which one will be able to detect light of wavelength 600 nm?

6. A parallel beam of monochromatic light falls normally on a narrow slit of width '$a$' to produce a diffraction pattern on the screen placed parallel to the plane of the slit.
Use Huygens' principle to explain that the central bright maxima is twice as wide as the other maxima.

7. (a) Write the conditions under which light sources can be said to be coherent.
(b) Why is it necessary to have coherent sources in order to produce an interference pattern?

(c) Write the conditions on path difference under which (i) constructive (ii) destructive interference occur in Young's double slit experiment.

**OR**

What is a wavefront? How does it propagate? Using Huygens' principle, explain reflection of a plane wavefront from a surface and verify the laws of reflection.

8. The fission properties of $^{239}_{94}Pu$ are very similar to those of $^{235}_{92}U$. The average energy released per fission is 180 MeV. If all the atoms in 1 kg of pure $^{239}_{94}Pu$ undergo fission, then find the total energy released in MeV.

9. (a) Light of wavelength 2000 Å falls on a metal surface of work function 4.2 eV. What is the kinetic energy (in eV) of the fastest electrons emitted from the surface?
   (b) What will be the change in the energy of the emitted electrons if the intensity of light with same wavelength is doubled?
   (c) If the same light falls on another surface of work function 6.5 eV, what will be the energy of emitted electrons?

10. How does the refractive index of a transparent medium depend on the wavelength of incident light used? Velocity of light in glass is $2 \times 10^8$ m/s and in air is $3 \times 10^8$ m/s. If the ray of light passes from glass to air, calculate the value of critical angle.

**OR**

An optical instrument uses an objective lens of power 100 D and an eyepiece of power 40 D. The final image is formed at infinity when the tube length of the instrument is kept at 20 cm.
(i) Identify the optical instrument.
(ii) Calculate the angular magnification produced by the instrument.

11. (a) Name the constituent radiation of electromagnetic spectrum which is used for
(i) aircraft navigation.
(ii) studying crystal structure.
Write the frequency range for each.
(b) The small ozone layer on top of the stratosphere is crucial for human survival. Why?

## SECTION - C

**12. CASE STUDY : TOTAL INTERNAL REFLECTION**

Total internal reflection is the phenomenon of reflection of light into denser medium at the interface of denser medium with a rarer medium. For this phenomenon to occur necessary condition is that light must travel from denser to rarer and angle of incidence in denser medium must be greater than critical angle (C) for the pair of media in contact. Critical angle depends on nature of medium and wavelength of light. We can show that $\mu = \frac{1}{\sin C}$.

(i) Critical angle for glass air interface, where $\mu$ of glass is $\frac{3}{2}$, is

(a) 41.8° (b) 60° (c) 30° (d) 15°

(ii) Critical angle for water air interface is 48.6°. What is the refractive index of water?

(a) 1 (b) $\frac{3}{2}$ (c) $\frac{4}{3}$ (d) $\frac{3}{4}$

(iii) Critical angle for air water interface for violet colour is 49°. Its value for red colour would be

(a) 49° (b) 50° (c) 48° (d) cannot say

(b) The small ozone layer on the top of the atmosphere is crucial for human survival because it absorbs harmful ultraviolet radiations present in sunlight and prevents it from reaching the earth's surface. These radiations can penetrate our skin and can cause harmful diseases like skin cancer etc.

**12.** (i) **(a) :** $\sin C = \frac{1}{\mu} = \frac{1}{3/2} = \frac{2}{3} = 0.6667$

$C = \sin^{-1}(0.6667) = 41.8°$

(ii) **(c) :** $\mu = \frac{1}{\sin C} = \frac{1}{\sin 48.6} = \frac{1}{0.75} = \frac{4}{3}$

(iii) **(c) :** From $\mu = \frac{1}{\sin C}$, $\sin C = \frac{1}{\mu}$

As $\mu_v > \mu_r \ \therefore \ C_v < C_r$

The correct alternative may be (c).

(iv) **(b) :** Difference between apparent and real depth of a pond is due to refraction. Other three are due to total internal reflection.

(v) **(c) :** As ${}^{w}\mu_g < {}^{a}\mu_w < {}^{a}\mu_g; \ \therefore \theta > \theta_2 > \theta_1$

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